

Front End Electronics for the STAR TPC and FTPCs

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In 1999, we completed installation and testing of the Front End Electronics (FEE) for the STAR Time Projection Chamber (TPC). Each of the 136,600 pads is connected to a 512 time bucket waveform digitizer. The digitizer consists of two custom integrated circuits: a 16 channel wide low noise preamplifier/shaper and a 16 channel wide 512 deep switched capacitor array; the latter has an integrated 12 bit Wilkinson ADC. The system is completely installed and working as designed; well over 99% of the individual channels are working and within specifications.

Averaged over all installed channels, the system noise is about 1.2 ADC counts, or less than 1,000 electrons. Data is digitized to 10 bits of resolution, giving an 850:1 dynamic range. The TPC anode wire gain is selected so that a minimum ionizing particle signal is roughly 20 times the noise. Then, the system has a dynamic range up to 40 times minimum ionizing, appropriate for a 200 MeV/c proton.

The sample acquisition frequency is programmable to match the 512 time buckets to the 2 meter drift length; frequencies of 7-13 MHz are expected, depending on the gas in the TPC. When a trigger occurs, the sample clock is synchronized to the RHIC strobe, so that the clock phase is constant from event to event. Each time bucket is digitized to 10 bits. Readout is via 144 fiber optic links, with events read out in 10 msec. The system is integrated with the STAR slow controls system, with temperature and power supply voltage and current frequently monitored. Unruly readout boards may be shut down manually or automatically. Similarly, groups of 4 FEE cards (128 channels) may be switched off. This system also controls the on-board calibra-

tion pulser.

Also in 1999, we designed and produced prototypes for the readout boards for the STAR Forward TPC (FTPC). The electrical design for this system is similar to that for the main TPC. However, the shaping amplifier time constant was increased to about 400 nsec, to match the FTPC gas diffusion. We also altered the readout to match the FTPC design and fit in the very limited space. Each FEE card now reads out 64 pads. Each FEE card is smaller than the corresponding main TPC FEE cards, so the density is doubled. Because the FEE cards are not water cooled, the preamplifier power consumption had to be reduced, at a cost of some additional noise.

The readout board segmentation has also been significantly changed. Instead of 9 sections each reading out 4 32-channel FEE cards on 2 cables, the FTPC readout boards have 5 sections each reading out 3 64-channel FEE cards. Besides matching the FTPC, this arrangement greatly simplifies the design of the internal bus structure and state machines on the readout boards. Prototypes of these readout boards are in production.

References

- [1] S. Klein *et al.*, "Front End Electronics for the STAR TPC," IEEE Transactions on Nuclear Science **43**, 1768 (1996).
- [2] "The Forward Time Projection Chamber for the STAR Detector," F. Bieser *et al.*, MPI-PhE/98-3, Jan. 30, 1998.

Footnotes and References

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